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US 5376778 A

(58) Field of Search
UK CL (Edition O) **G4M MBF MCF**
INT CL^6 **G06K 7/00 7/01 7/08 17/00**
Online:WPI

(54) Abstract Title
Reading smartcards

(57) An active VHF transmitter/receiver unit and a card interact at radiation frequencies above 100 MHz across a fairly small distance. In order to avoid a change of transfer efficiency due to subtle alterations in antenna attitudes relative to each other, or in the spacing from each other, or in other modifications of the environment affecting the radiation resistance of the antennae the primary frequency of the oscillator source fluctuates, and is self-adapting to said random conditions.

Integrated Component
(Oscillator Circuit + Antenna).

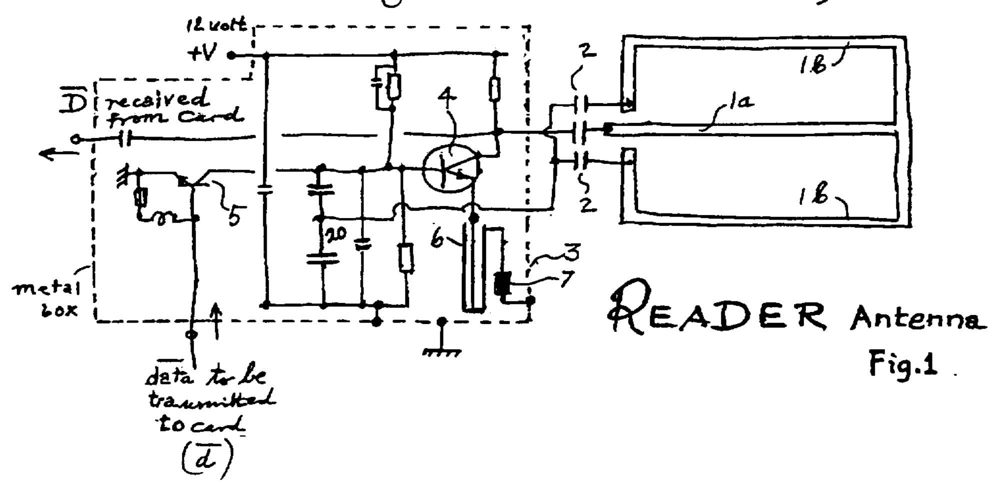

Fig.1

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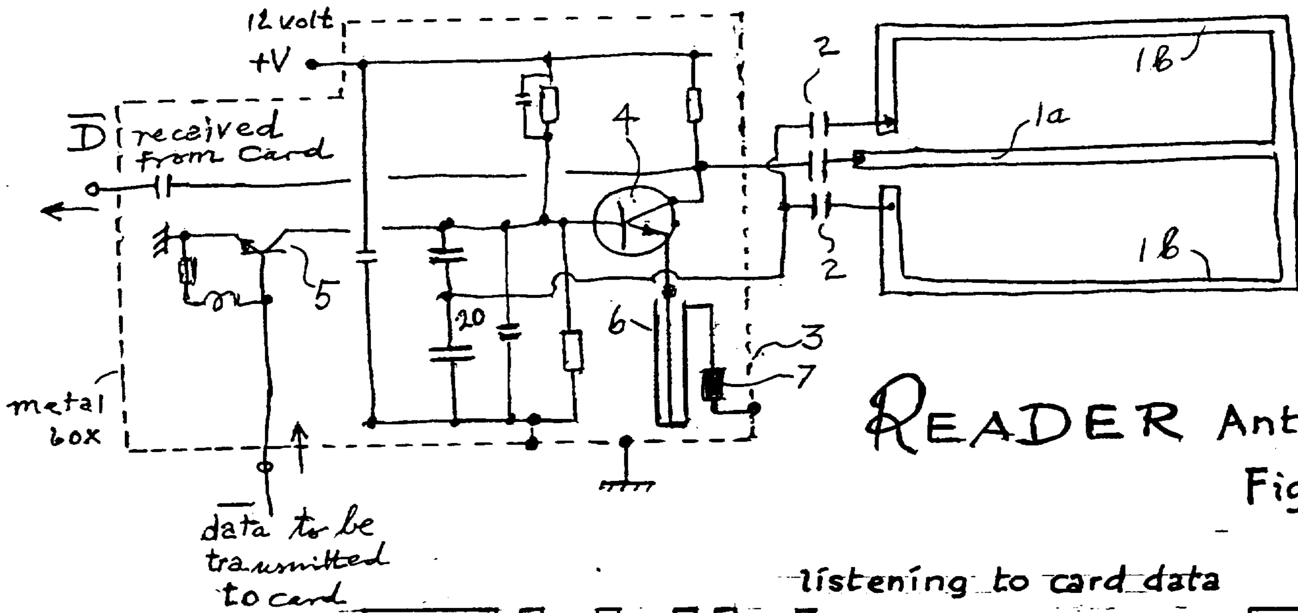
Integrated Component
(Oscillator Circuit + Antenna).



READER Antenna
Fig. 1

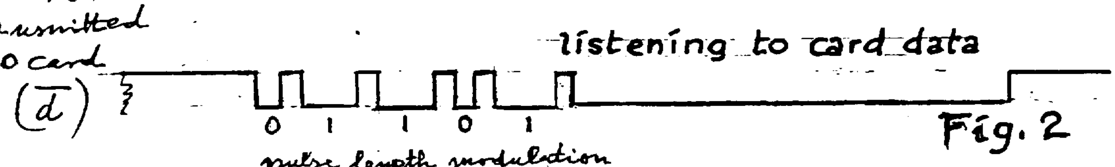
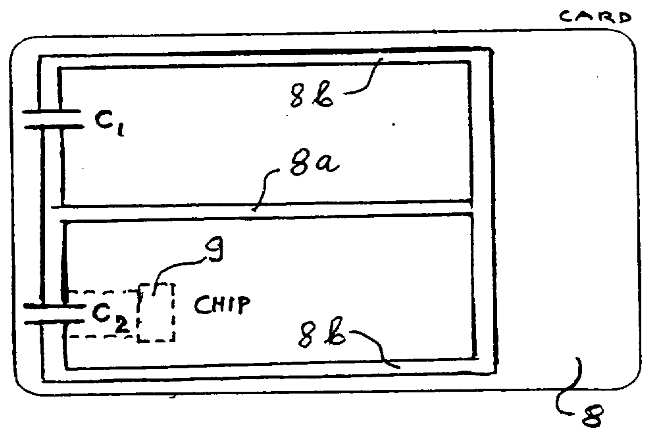


Fig. 2

Fig. 3

CARD Antenna



$C_1 = C_2$ (.5pf to 22pf)

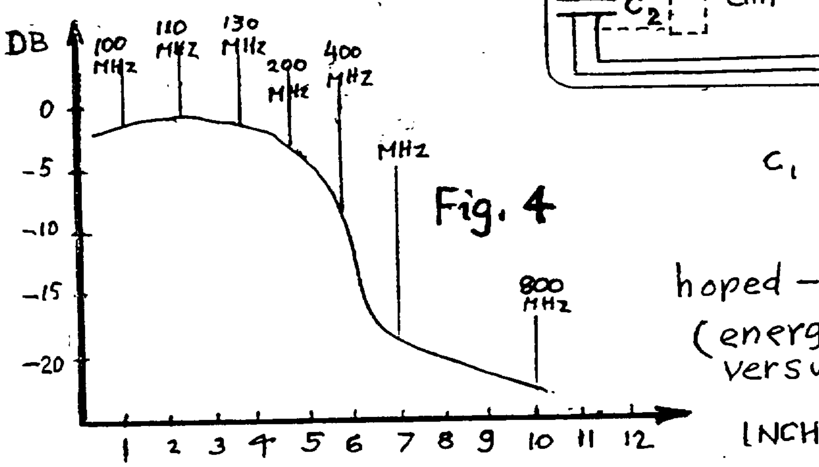
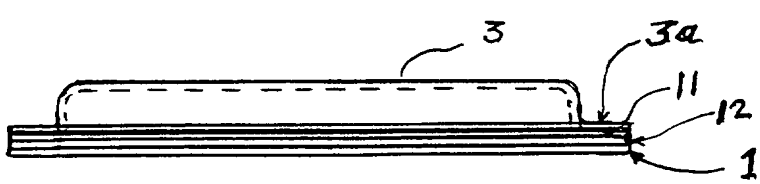


Fig. 4

hoped-for results,
(energy transfer versus distance.)

Fig. 5



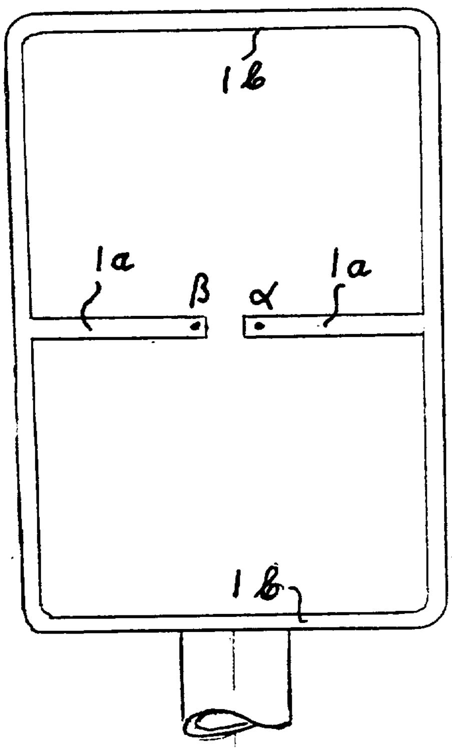


Fig.6

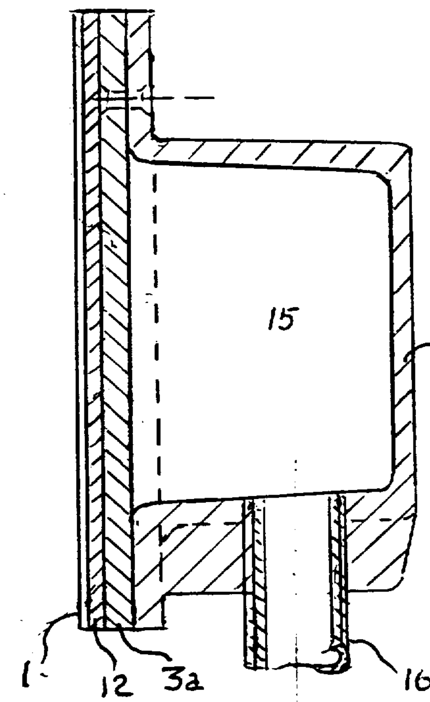


Fig.7

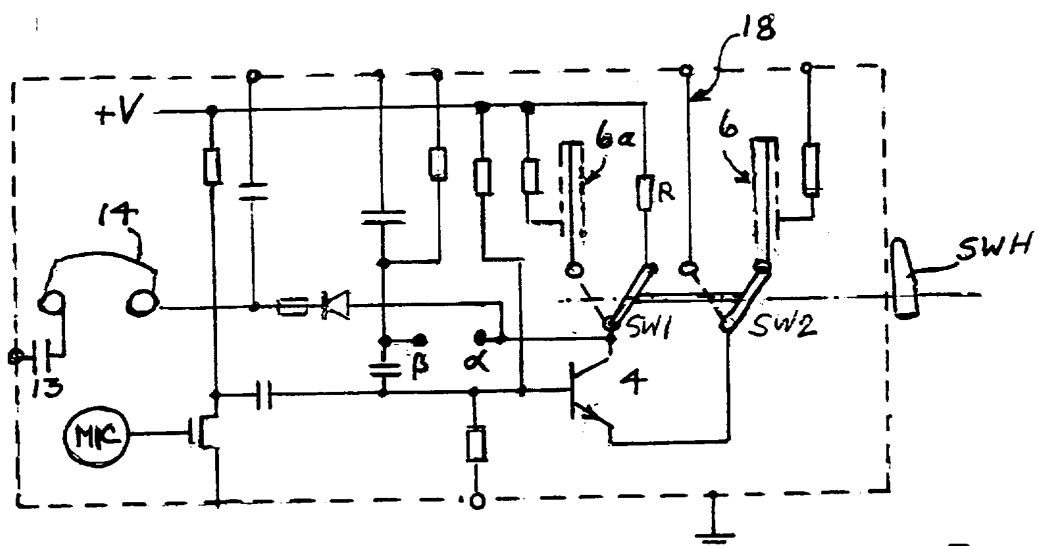


Fig.8

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Power Transfer between at variable distance coupled VHF antennas, and oscillator drive circuit for same.

In most countries of the world there are watchdog institutions to ensure that neither industry nor private citizens use electrical equipment which, either singly or in aggregation,produce electronic space pollution in excess of prescribed limits and criteria. In the scientific world many are anxious to introduce as little man-made radiation noise as possible.

On the other hand, there are newly developing techniques about to be introduced - such as the use of miniature computers contained in credit-and money cards interfacing with terminals via RF-coupled circuits. If millions of these device are in daily use, background noise is bound to increase.

My three patent applications as hereunder cited

GB 9605050.4 of March 22,1996

GB 9606764.0 " " 29,1996

and GB 9609102.0 " May 1, 1996

address the problem of powering a microprocessor chip from an antenna placed into a portable pocketsize component. The twin objective has been

(a) reducing the radiation at distances beyond five or six inches from the card terminal so that confidential data cannot be picked up by unauthorized persons

(b) drastically improving the ratio of usefully transferred power to total radiated power.

Whereas the means suggested in the above cited papers have in tests proven to be very effective in achieving the first-named objective, the second one could not be said to have been reliably achieved because of the sensibility of VHF antennas to environmental conditions and the inherent narrowness of the bandwidth in the matched condition. There was a preponderant uncertainty as to whether optimum transfer conditions can be reliably repeated even with the best of precautions.

At this point it was important to realize that it was quite irrelevant for the transfer of energy and even less so for the transfer of data, at which precise carrier frequency it is taking place. Therefore, the idea of employing a rigidly fixed carrier frequency could be abandoned. Instead, theVHF generator may be allowed at any moment to adjust its frequency to that one at which (as a result of all the contributive factors present) free oscillation would happen; this would automatically ensure that also the coupled antenna is optimally matched irrespective of the distance between the sending and receiving antennas.(i.e. within the reduced range geometry due to the said M-shaped or twin-loop antenna elements as described in the cited patent applications).

This is the essence of the present patent application which can readily be added to the principles described in the cited three earlier patent applications, and the implementation of which may be achievable by a variety of circuits and antenna layouts.

In the drawings which give specific examples of execution Fig. 1 shows an electric circuit closely connected to a VHF antenna. A coaxial feed line is deliberately avoided as its inherent impedance would reduce the adaptability of the circuit. Fig. 2 shows two versions of encoding digital data for modulating the power output of the circuit of Fig. 1, by way of example.

Fig. 3 shows the inherent simplicity of the card antenna circuit using conductive laminates and small discrete capacitors.

Fig. 4 illustrates with some exaggeration the kind of frequency variation that might occur when the card antenna is gradually brought near to the Reader antenna. The aim is to get reasonably constant power betweenfour and zero inch spacing while beyond four inches spacing a rapid reduction of the power transfer would take place.A negative feedback circuit also reduces the radiating wattage at higher frequences, thus compounding the primary effect.

Fig. 5 gives an indication of the possibility of producing a compact component made up of the VHF compartment and the laminate antenna.

Fig. 6 shows the twin-loop arranged in such a way that the connections α and β with the VHF drive circuit, come conveniently to be placed fairly in the middle of the cardlike surface.

Figure 7 shows an arrangement of an outdoor terminal which may be either a fixed terminal or a light portable one powered by a battery.

Fig. 8 shows a portable terminal that provides a switch with the option to communicate with a card either at a fixed high frequency, or with a card at a variable frequency. - This does not duplicate notes in one of the earlier(cited)patent applications on the choice of a carrier frequency which would affect the antenna system only by causing in it a unison linear resonance which, too, can drive the card chip and would be effective over relatively larger distances between a terminal and a chip card.

<u>Description of the Drawings</u>. (Please note: The figures on sheet I are being re-drawn spreading them over two sheets to comply better with regulations. They will be forwarded to the Patent Office on receipt of a request to do so).

Figure 1 shows a high-speed NPN transistor 4 which is over the shortest possible path connected to the twin-loop antenna with its center branch 1a and its two side branches 1b. In this example, this is done via coupling capacitors 2, with the center branch 1a connected to the collector, and the outer branches via a voltage divider to the base of the transistor. When power is switched on a pulse applied to branch 1a travels via the two outer branches reaching the base of the transistor reduced in amplitude, after a definite delay period. This causes an increase in transistor current and a voltage drop at the collector, i.e. a negative going pulse applied to center branch 1a. This in turn will appear at the transistor base after the said delay period and cause an increase of voltage at the collector point, i.e. a positive going pulse to the branch 1a. The condition for the build-up of an oscillation are given and this continues until radiation and other losses equal the power introduced.

If the antenna branches 1a, 1b extend over the full length of a standard credit card, the resonance frequency would be in the order of o,9 gigahertz (GHz). For the purpose of sending digital data, various forms of amplitude modulation may be used and figure 2 shows an inverted pulse length modulation for input to the base of transistor 5. When the Reader antenna listens to card data, the input to gate or base 5 must be kept low.This keeps the transistor 5 in the conductive state with the antenna 1a, 1b radiating.

Fig. 3 shows an example of a card antenna with built-in chip 9. As explained in the priority applications, the antenna strips 8a 8b, and connecting links would consist of thin metal folio or plastic folio with deposited metal film. The metal need not be of the inert ones such as gold,platin or the like since the conductors would not be exposed to the athmosphere.Small lumped capacitors c1 and c2 may be placed into each loop path so as to lower the natural resonance frequency of the card antenna. Their purpose is to lower the mutual resonance point when the card is presented to the Reader antenna.

Fig. 4 gives an idea of the frequency changes of the Reader-Card oscillator system as the spacing between Reader and card is reduced. The figures entered into the diagram are not derived from measurements. Frequences will be lowered inverse proportional as the root of the mutual inductance increases.

Fig. 5 is a side view of the integrated component according to the invention. It consists of a shielded soace inside a metal shell 3 which contains the VHF circuitry. Also shown are the flange portion 3a, a lid plate 11, a ferrite plate 12 which concentrates the forward-directed electromagnetic flux, and finally the laminated sheet 1 containing the Reader Antenna of Fig. 1 The metal container 3 may also contain a compartment for a battery (not shown).

Returning to Fig. 4, it can be seen that a steep fall in flux energy is expected in the transition from an antenna spacing at 6 inches. This would be due partly to the antenna configuration as shown, partly by the introduction of a negative feedback into the emitter of the transistor 4 (fig. 1), by means of a coaxial resonator 6 representing the ground connection for the

said transistor. This resonator may be tuned to about 0.9GHz and would already at a frequency below that value represent a negatively acting impedance thereby reducing the oscillator power very rapidly if no card is nearer than 5 to 6 inches from the transaction point. For card distances below 5 inches the natural resonance frequences are not affected by the coaxial resonator 6 which then simply acts as a ground connection.

Figs 6 and 7 show the front and side elevations of a card terminal which feasibly may be used for outdoor installations, or as a mobile outdoor unit. In Fig. 6 it will be observed that the antenna layout is modified, mainly to get the endpoints for the twin loops into the center of the antenna area. (α and β). From these points, metallic connecting pins may reach into the space 15 (Fig. 7) for easy plug connection to the circuitry placed into that space.

In Figure 7, one can again distinguish the laminated antenna sheet 1, the ferrite insulator plate 12, and the sturdy lid 3a. A threaded tubular handle or support tube 16 furnishes an airtight closure to prevent humidity from entering into space 15.

The circuit of Fig. 8 shows up the antenna connecting points α and β, but is otherwise very similar to that shown in Fig. 1. It is here used also to indicate two further features which may be in demand. One is the substitute, or the addition, of analogue communication facilities producing analogue modulation of the field covered by the twin-antenna geometry. Accordingly, the input to the base of transistor 4 consists of a microphone MIC and the digital data output is replaced by a diode controlled detector circuit and earphone 14.

The second feature is a facility to choose between the already described de-emphasis of the short wave spectrum of resonance possibilities (by means of resonator 6 in the emitter to ground connection) and an emphasis for the shortwave or gigahertz region. A switch handle SWH can externally actuate switches SW1 and SW2 to produce the changeover to a connection where the resonator 6 is replaced by a straight ground connection 18, and the resistor R in the collector of transistor 4 is substituted by another resonator 6a. Similar switches may be provided to produce a change-over from twin-loop to single loop mode, for temporary range extension.

C L A I M S

1. A twin-loop antenna configuration capable of electromagnetically oscillating in at least two modes, one in which the antenna loops oscillate in phase opposition and a second mode wherein the antenna currents oscillate linearly in unison even though at a higher frequency, a n d w h e r e i n the oscillator drive circuit is mounted on the same support structure as the antenna conductors, this system further characterized by a high degree of dependence of the oscillating frequency upon the radiation resistance changes of the antenna to which it is linked.

2. A system of energy transfer from a card transaction terminal to a chip card wherein the chip carrier (card) consists of layers of bonded laminates one or more of which carry a twin-loop antenna consisting of a middle branch and two side branches on either side thereof and are transversally connected to the middle branch, either of which may optionally be interrupted for the insertion of a capacitive or inductive link element, and wherein the Reader antenna has broadly the same size and shape, and is connected to a transmitter drive circuit whose oscillating frequency is strongly co-determined by the mutual inductance and coupling conditions of the card antenna and Reader antenna when brought into mutual proximity.

3. A system of energy and data transfer as in Claim 2, wherein the by the transmitter circuit produced carrier is amplitude modulated and wherein the data are encoded as pulse- or interval length variations or pulses with different rise times to represent binary magnitudes, for storage in the message receiving data processor unit.

4. A system of energy and information transfer as in Claim 2 wherein the binary data are represented by frequency shifts imposed on the radiated energy.

5. A system of energy and information transfer as in Claim 2 wherein the binary data are represented by phasing shifts imposed on the radiated energy.

6. A system of energy and information transfer as in Claims 1 and 2 w h e r e i n the oscillation drive circuit is modulated by amplified microphone voltages, and the selfsame circuit is also equipped with a detector for such analogue variations as are imposed by radiation resistance changes in the proximity environment of the said antenna.

7. An oscillator drive circuit as in Claim 1 which also contains connection switching elements accessable to manual operation via electronic or mechanical switches so as to put the said antenna from its normal twin-loop operating mode into a linear or uni-directional oscillation mode.

8. An oscillation drive circuit as in Claim 1 or 7 which also contains switching elements between the circuit and the said antenna accessable to manual operation via electronic or mechanical switches so as to put said antenna temporarily from its normal twin-loop operating mode into a single loop mode.

9. An oscillation drive circuit as in Claim 1 which also contains means to emphasize the emission of a certain range in the feasible frequency spectrum, such as tuned chokes or filters emphasizing a certain frequency band,with the object of either weakening or strengthening the emission of that range relative to others, and optionally switching elements in said circuit accessable to manual operation via electronic or mechanical switches (SW1, SW2 fig. 8) in order to achieve temporarily a corresppondingly modified performance of the said energy and information transfer arrangement.

10. A system and device for the transfer of energy and signals by prevailingly proximity radiation as illustrated in the drawings and described in the explanatory statement.

The Patent Office

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Application No: GB 9627120.0
Claims searched: 1 to 10

Examiner: John Donaldson
Date of search: 29 January 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): G4M(MBF, MCF)

Int Cl (Ed.6): G06K 7/00, 7/01, 7/08, 17/00

Other: Online:WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	US 5376778 (KREFT), see column 1, line 41 to column 2, line 19	-

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
& Member of the same patent family
A Document indicating technological background and/or state of the art.
P Document published on or after the declared priority date but before the filing date of this invention.
E Patent document published on or after, but with priority date earlier than, the filing date of this application.